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ABSTRACT

This paper presents an overview and analysis of field houses, stadiums, arenas, and campus recreation centers. All are large indoor sports or recreation facilities. In general, stadiums and arenas are spectator facilities while field houses and campus recreation centers are primarily designed for activity. A college field house is a structure that encloses large open areas for sports and recreational activities. Campus recreation centers, a fast growing concept, are designed to improve the quality of campus life. Examples of each of these structures is provided, with locations and descriptions. To ensure that any new construction of a large sports or recreation facility will meet the present and future needs of users, a number of considerations must be addressed during the planning process: site selection; single use versus multi-purpose facilities; modules; lighting, heating, ventilation, and air conditioning; entrances, exits, and lobbies; facility management offices; rest rooms; storage; spectator seating; and sight lines. Innovations in construction types include: geodesic domes; fabric structures; tension structures; air-supported structures; combined air-supported and tension structures; and portable air structures. (Contains 12 references.) (LL)

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LARGE INDOOR SPORTS AND RECREATION FACILITIES

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Large Indoor Sports and Recreation Facilities

INTRODUCTION

This chapter will present an overview and analysis of field houses, stadiums, arenas, and campus recreation centers. All are large indoor sports or recreation facilities and may have many features in common. Which category a particular building may fall under is often open to debate and may be determined by what the owner decides to call it. In general, stadiums and arenas are spectator facilities while field houses and campus recreation centers are primarily designed for activity and spectator seating is usually limited.

FIELD HOUSES

Field houses were first constructed in the United States to meet storage needs near outdoor sports fields. In inclement weather, it was a natural step to move practice periods for outdoor sports under the roof and onto the dirt floors of the field house. As field houses increased in sophistication, dirt floors became unacceptable, and flooring surfaces were added that included wood, asphalt, synthetic surfaces, and artificial turf. Designers began to include locker and team rooms, full plumbing, offices, and spectator accommodations which provided wider indoor recreational and instructional usage.

Today, the building most commonly referred to as the field house is a structure that encloses large open areas for sports and recreational activities. Some field houses are large enough to contain a full size football field, a 200 meter running track, swimming pools,

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and a multitude of court set-ups. In general, low cost construction systems are used in order to achieve a large amount of activity area for a reasonable price.

Time and the development of these low-cost construction techniques has made it difficult to differentiate between the gymnasiums built in recent years and field houses. Historically, the gymnasium was a small enclosed area for indoor sports usually within a main school building. Today it is generally a large multi-use facility located in a wing of a building or as a separate building. In many cases, the gymnasium and field house have become synonymous.

Activities performed in the field house include instruction in physical education, practice for intercollegiate athletics, intramural, interscholastic or intercollegiate competition, informal recreation, exhibitions, dances, commencement exercises, registration, and final examinations. Community uses may include concerts, exhibits, various forms of entertainment, recreation, and mass meetings.

Many field houses allow two or more activities to take place at the same time. This is usually accommodated by dividing activity areas with a system of movable nets or curtains that hang from the ceiling.

Examples

• **Cornell University** - This field house is comprised of two primary areas. These areas include a gymnasium with three full basketball courts and roll out seating for 5,000 and an artificial turf field area. Opened in 1990, it also contains an indoor climbing wall, classrooms, meeting rooms, locker rooms, training facilities, and offices.

• **William Farley Field house** - This 60,000 square foot field house is a major part of the 100,000 square foot Bowdoin Athletic Complex at Bowdoin College in Brunswick, Maine. Opened in 1987, the field house contains a six-lane, 200 meter track, a separate free weight area, and 6,500 square feet of translucent panels to allow for natural lighting. The infield consists of four tennis courts with a system of movable nets to divide activity spaces.

• **Freeman Athletic Center** - Located on the campus of Wesleyan University in Middletown, Connecticut, the field house provides a 60,000 square foot synthetic surface. It includes a six-lane 200 meter track, three basketball courts, and four competition and two recreational tennis courts. Opened in 1990, the field house is only a part of a $21 million recreational, intramural, and intercollegiate athletic facility expansion project.

• **National Institute for Fitness and Sport** - This $10.5 million facility is located in Indianapolis, Indiana and was opened in 1987. The activity area of this 120,000 square foot facility contains a 200 meter running track, aerobic room, weight room, and serves as the training facility for the United States Gymnastics Federation. The 200 meter track is unique in that the curves can be flat or banked and can be adjusted hydraulically. Also included in the facility are a complete exercise testing and research center, exhibit hall, 120 seat auditorium, resource library, offices and locker rooms.

Indoor Football Practice Field houses

Indoor football practice buildings are another version of the field house that is becoming more common. These structures are usually

designed for football to be the primary activity and sometimes the only activity. Other activities may occasionally use the facility but often no accommodations have been made for these activities. Most often found in colder climates, these field houses usually contain a full size, or near full size artificial turf football field. These football field houses may also contain offices, a weight room, locker rooms, and a synthetic track around the field. Some schools find that having an indoor football facility is as important for recruiting as it is for practice.

Examples

• **University of Michigan** - Opened in 1980, the Indoor Practice Facility was the first field house built primarily for indoor football practice. It contains a 120 yard synthetic turf football field with end zones, two regulation goal posts, and has a 75 foot high ceiling. Construction cost was $1,800,000.

• **Loftus Sports Center** - Located at the University of Notre Dame, this $6.4 million field house contains a full size football field that is surrounded by a 5 lap per mile track. A 7,000 square foot weight room, locker rooms, lecture room, and offices are included in this 135,000 square foot structure. Opened in 1987, the field can be divided into separate activity areas by a state of the art, computerized netting system.

• **Kent State University** - Opened in 1989, this $7,000,000 football field house covers 120,000 square feet. It houses a full size football field, a six-lane 320 yard track, a weight room, locker rooms, and offices. An advanced netting system allows for several activities to be conducted simultaneously. Partially funded by student fee, this facility is used by the entire student population.

INDOOR STADIUMS

Stadiums are usually built more specifically for exhibition purposes with mass seating. Until recently, stadiums were almost exclusively outdoor facilities but with the advent of new structural technologies, more indoor stadiums are being built. In addition to competitive athletic events, these structures are often used for such purposes as convocations, concerts, various forms of entertainment, mass meetings and rallies.

Examples

• **Astrodome** - The Houston Astrodome was opened in 1965 and was the first of the huge indoor stadiums. The roof is 642 feet across and is based on the principles of the geodesic dome. It is made up of 4,596 rectangular panels of clear Lucite and was originally designed to allow direct sunshine to enter in order to allow the growth of natural grass. Baseball players found that the resulting glare made catching fly balls too difficult so the solution was to tint the Lucite gray. The resulting decrease in sunlight was not enough to maintain the grass and this is what prompted the development of Astroturf. The Astrodome seats 55,000 for baseball and 65,000 for football.

• **SkyDome** - Located in Toronto, Ontario, SkyDome is presently the only stadium that has a fully retractable roof. Opened in 1989, SkyDome can completely open or close the entire steel trussed roof in 20 minutes. This is accomplished by three movable roof sections, two of which slide and another that rotates. The stadium seats 50,600 for baseball, 53,000 for football, and has different seating arrangements

for concerts ranging from 10,000 to 70,000. It also contains 161 luxury SkyBoxes, a 348 room hotel and health club, full broadcast facilities, underground parking, and a 110 x 33 foot state-of-the-art video screen. Original estimates of the cost for SkyDome were $184 million (Canadian) but ended up costing about $585 million.

• **FARGODOME** - Scheduled for opening in early 1993, the FARGODOME is located in Fargo, North Dakota. The roof is pre-formed structural steel and rises to a height of 115 feet above the playing surface. This multi-purpose facility will seat 19,300 for football, about 11,000 for basketball, hockey, or tennis, and about 32,000 when set up for concerts. The FARGODOME will contain about 470,000 square feet and should cost close to $43 million.

ARENAS

Arenas are generally large indoor spectator facilities. Often it may be difficult to tell the difference between the large arenas and indoor stadiums. Webster's Dictionary defines a stadium as "A large usually unroofed building with tiers of seats for spectators at sports events", and an arena as "An enclosed area for public entertainment". Both are large enclosed spectator facilities with the main differences being that stadiums tend to have a greater amount of spectator seating and are designed to handle field sports such as football and baseball. Arenas usually tend to be designed more for court type activities such as basketball.

Examples

• **University Arena** - Located at the University of New Mexico in Albuquerque, the Pit first opened in 1966. It was originally built for the bargain price of $1.4 million dollars and seated 14,800 all of

which were ground level or below. Several years later the seating was expanded to 17,100. Over the 25 years of it's existence, the Pit has averaged 15,993 fans for U.N.M. basketball games with the largest single crowd recorded at 19,452. The initial cost of the Pit was kept so low because of the unique construction process used. The walls and roof were erected first, a large hole was then excavated and the concrete for the floor and seating areas was poured. Even as old as it is, the Pit is still considered to be one of the top five spectator arenas in the country.

• **Ball State University Arena** - Opened in 1991, the Arena is a part of a $29.5 million dollar building project. Designed as a multi-purpose activity center, it features permanent and portable seating for 12,000 spectators, as well as 32 permanent wheelchair positions. Full men's, women's, visiting team, and officials locker rooms are provided as well as a full kitchen. In order to enhance television coverage, fixed camera positions with permanent cable runs are provided.

• **America West Arena** - Opened in 1992, the America West Arena is located in Phoenix, Arizona and is jointly owned by the city of Phoenix and the Phoenix Suns basketball team. This $89 million multi-purpose arena seats 19,000 for basketball and has 87 luxury suites for lease. Other events scheduled include Arena Football, concerts, circus', and other shows and exhibitions. Complete ice rink facilities are also included.

• **Jack Breslin Student Events Center** - Completed in 1989, the Breslin center is located at Michigan State University. This multi-purpose facility was built for a cost of $43 million and can seat 15,138 for basketball. The spectator seating is a combination of bench and

chairback seats as well as eight luxury boxes. The Center also contains an 8,000 square foot auxiliary gym, conference rooms, weight room, locker rooms, press room, training room, and offices. A ramp and tunnel at the south end permit truck access to the arena floor.

Trends in Arena and Stadium Design

Historically, most large arenas and stadiums have been funded by city or state governments, or by colleges and universities. Recently these entities have had tighter budgets and, more than ever, the emphasis is on making a profit. The current trend is more toward private funding. In order to make such a large investment profitable, every effort must be made to ensure that the facility be able to accommodate as many different events and kinds of activities as possible. Recent design improvements have also focused on being able to change over from one event to another as quickly as possible. Some facilities now schedule from 250-600 events per year including sporting events, concerts, conventions, trade shows, rodeos, monster truck shows, and professional wrestling. Efficient design can allow a crew to change the set-up for one kind of event to another in a matter of hours. This means that more than one event can take place in the same day. Several aspects of design that allow a facility to accommodate a wide variety of events and also to quickly alter the set up for different events include:

- Versatile lighting and sound systems that can adequately handle the wide variety of events.

• Ramps that allow semi-trucks to back all the way to the floor. Even better, some facilities provide floor access for two or more trucks at a time so that one can be loaded while another is unloaded.

• Heavy duty lighting grids that can be lowered to the floor in order to enhance the placement of sound and lighting equipment for concerts.

• Fixed, pre-wired camera positions that for allow for quick and easy set-up for television broadcasts. The Palace of Auburn Hills even has a full television production studio which permits a television network to broadcast a game without bringing in their semi-trucks full of production equipment.

• A movable arena floor such as the one in the Target Center in Minneapolis, MN. This floor can be raised and lowered a full five feet in order to maintain good sight lines for either event. For basketball, the floor is in the bottom position and temporary seating extends all the way down to courtside. When changing over for hockey, some of the temporary seats are removed and the 2.5 million pound, computer controlled floor is elevated five feet. This eliminates the old problem of having to lay the basketball floor on the larger surface of the hockey rink and then setting up temporary seating around the perimeter of the floor on a flat surface. These seats may be close to the action but since several rows of seats are on the same level, the sight lines are poor.

Another trend in arena and stadium design is the move toward more upscale facilities and greater service and convenience for the spectators. Some aspects of this trend include:

• More rest rooms. In the past, many spectator facilities provided only enough rest rooms to satisfy the local code requirements. This often results in long lines and frustration on the part of the spectators. Many facilities are now being designed with up to twice as many rest rooms as the minimum required. Since some events may draw a disproportionate number of men or women, consideration should be given to designing some rest rooms that can serve either sex simply by changing the sign on the door.

• Taking into consideration the requirements of those customers with handicaps is a priority. With the advent of the Americans With Disabilities Act, full accommodation of the needs of the disabled is now federal law.

• The building of larger concourse areas and the addition of separate concourses to serve different levels. Improved access and less crowding makes these areas more attractive. Some concourse areas are being designed to resemble a mini-mall by offering many different choices of food and novelty items.

• One of the most significant trends in stadium and arena design is the addition of luxury boxes or suites. These suites are usually leased to individuals or companies who desire a semi-private lounge area, usually large enough to accommodate about 20 guests. Suites are normally leased on multi-year contracts and are furnished and decorated by the tenant. The prevalence of these luxury suites is growing rapidly primarily because they are such good revenue producers. The Palace of Auburn Hills is a good example of how important suites have become to the economics of this type of facility. The original plans called for 100 luxury suites to be built as part of the

arena. About one-third of the way through construction, all of the suites had been rented. Some quick design changes by the architect added an additional 80 suites, that made for a total of 180. The added suites were also leased by the time The Palace opened. Total construction cost was about $63 million and the income from the rental of the suites alone is about $11 million per year. Luxury suites have become a significant trend and may make the construction of future arenas and stadiums more economically feasible.

CAMPUS RECREATION CENTERS

Campus recreation centers are one of the fastest growing concepts on college and university campus' today. These centers are not designed along the lines of the typical physical education/recreation buildings of the past. The new breed of rec center often includes not only the gyms, pools, weight rooms, racquetball courts, etc. that one would expect to find, but also indoor jogging tracks, leisure pools, game rooms, TV rooms, bowling alleys, study rooms, food service, and other areas designed to improve the quality of campus life. These recreation centers are often constructed primarily for campus recreation, with an emphasis on social recreation, and may tend to limit use by physical education classes or athletics. They are often designed to be the hub of campus social life.

Trends in Campus Recreation Centers

- Many recreation centers are being built with a large central corridor along which all of the activity areas are located.

Typically there are large windows into the various activity spaces. This "main street" gives the feeling of a shopping mall and allows those not interested in participating in an activity, the opportunity to observe others at play or to just "hang out".

- Climbing walls are gaining in popularity and may be located either on inside or outside walls. These walls are designed to allow for safe climbing instruction and practice in a controlled setting. Climbing walls can be a cause for concern of liability and should be planned with adequate security precautions in mind.
- Innovations are appearing all the time in campus rec centers. A recent feature found in colder climates are all purpose gyms that are designed to accommodate floor hockey. These rooms are built with rounded corners and have walls that are designed to withstand the abuses of being hit by flying pucks, sticks, and bodies. This was introduced at Eastern Michigan University in the early 1980's and are now also located at the University of Toledo, Central Michigan University, and others. This design increases the usability of the room and does not limit traditional activities such as basketball, volleyball, and aerobic dance from taking place. These rooms have proven to be very popular at the above institutions.
- Another trend in recreational facilities is the move away from building competitive pools and constructing leisure pools instead. Leisure pools are designed for play and are very different in concept. Typical leisure pool design features

include water slides, current channels, wave machines, waterfalls, plunge tanks, and a high percentage of shallow water. Another common feature is called a zero-depth pool. This consists of a dry deck area that slopes down into the water and gradually increases in depth. This simulates a beach area and makes a great area for play or lounging. Usually a large deck area by the pool with spas, saunas, or steam rooms is included to allow for pool parties.

- The variable depth pool floor is becoming more common in recreational facilities. Typically, these floors can be adjusted from a depth of four feet up to deck level or any where in between. This allows for tremendous flexibility in use of the pool. At zero depth, wheel chairs can be rolled onto the floor and then lowered to the desired depth. The floor can be set at six inches for water play for infants or to four feet for lap swimming. The initial cost of a variable depth floor is higher than standard pool design but can dramatically increase the programming possibilities.
- Many recreation centers are providing up scale locker rooms that give more of a feeling of belonging to a private health club. In place of the humid, harsh feeling of the traditional locker room, an effort is being made to transform these areas into a more warm, friendly, and inviting atmosphere. Carpeting, upscale lockers, having at least a few private shower stalls, steam rooms or saunas, music, good ventilation, hair dryers, and soft lighting are a few of the amenities sometimes found in

these locker rooms. Careful consideration should always be given to security and supervision of locker areas.

- Other features that may help give the feeling of being in a private health club are often included in recreation centers. Many are opening pro shops that sell sports equipment such as balls, racquets, and shoes, along with other supplies and clothing. Juice bars and health food snack bars are also appearing more often in an attempt to make the facility more attractive to the student population.

Possible Future Trends

Experts in the field of recreational facility design predict that some of the features we will be seeing in the future may include locker rooms with family dressing areas, wave pools, child care, and food service.

Examples of Campus Recreation Centers

- **Eastern Michigan University** - The first of the large campus recreation centers that emphasized a health club type atmosphere, this facility opened in 1982. A list of features includes four full basketball courts, a 50 meter pool with one and three meter boards and five, seven, and ten meter platforms, a club pool with whirlpool, sauna and two habitat rooms. These are small rooms that allow one or two people to experience music, steam, water sprays, heat, and wind. Four separate weight areas provide a total of 8,700 square feet of area for lifting. Also included within the recreation building are thirteen racquetball courts, an aerobics room, batting cage, combatives room, utility gym with rounded corners for floor hockey, a 9.8 laps per mile

jogging track, pool hall, dining room with food service, and a full service sporting goods shop.

• **University of Toledo** - Located in Toledo, Ohio, this campus recreation center was opened in 1990. It is truly a multi-purpose recreational activity center that includes a gym with six full basketball courts, an enclosed rounded corner floor hockey room, a 300 meter suspended jogging track, free weight room, machine weight/fitness area, 25 meter x 25 yard competitive pool, leisure pool with water slide, plunge tank (diving pool), six glass wall racquetball courts, aerobic dance room, snack bar/restaurant, table game area, social lounges, meeting rooms and auditoriums, locker rooms, and offices.

• **Vanderbilt University** - The Student Recreation Center encompasses 132,000 square feet and was opened in 1990. Located in Nashville, TN, the SRC was built for a cost of $14.2 million. It contains a gymnasium with three full basketball courts, a 9.2 laps per mile jogging track, a $33^1/_3$ meter x 25 yd. pool, six racquetball courts, two squash courts, a 6,000 square foot weight room, two multipurpose activity rooms, locker rooms, food services, lounge, and offices. A 28 foot high x 20 foot wide climbing wall is located just inside the main entrance. The activity spaces are arranged along a 320 foot, two-story corridor from which many of the activities may be viewed.

• **Arizona State University** - Opened in 1989, the Student Recreation Complex contains 142,000 square feet and was built for a cost of $15.7 million. The facility contains three gyms with two basketball courts each, three multi-purpose/dance rooms, 15 racquetball courts, a 9,000 square foot fitness/weight room, rehabilitation/weight room, pro shop, locker rooms, and

administrative office space. Instead of being confined to just the weight room, a large number of aerobic exercise machines such as stair-climbers and stationary bikes, line the lobbies and corridors and allow for a wide variety of views and locations in which to work out. Outdoor activity areas include several intramural fields, tennis courts, sand volleyball courts, and a 70 meter x 25 yard pool with two movable bulkheads.

• **Central Michigan University** - The Student Activity Center, located in Mt. Pleasant Michigan, is designed to be the center of campus social life. Most activity areas in the building are located adjacent to a large mall-like concourse that divides the building in two. This 450 x 24 foot corridor provides visual access to most of the activity areas and serves as a place for students to gather and socialize. The facility contains six basketball courts, two floor hockey/multi-purpose rooms with rounded corners, a 25 yard pool with variable depth floor, a 25 seat spa, sauna, a 12 lane handicap accessible bowling alley, a 9,000 square foot fitness room containing aerobic equipment and weight machines, a free weight room, six glass back wall racquetball courts, study areas, food service, and more making the Student Activity Center the focal point for socialization for the entire campus.

GENERAL PLANNING CONSIDERATIONS

In order to ensure that a large sports or recreation facility will meet the present and future needs of the users, a number of considerations must be addressed during the planning process. A preliminary study must be conducted as a basis for writing the building

program. A partial list of factors that should be included in this study are an analysis of the present program, desired future program changes, financial considerations, site availability and adequacy, local, state, and federal codes and regulations, aesthetics, and last but not least, a sound justification for the need for a new facility of this type.

A building committee must be formed and should include a representative from each of the major user groups that the facility will be built to accommodate. The committee itself should be kept to a fairly small and manageable size. If there are too many people involved, it will cause more problems than it will solve. The committee should seek out and welcome input and ideas from any person who is even remotely involved. Great ideas sometimes come from unexpected places. Those asked for input might include current faculty, staff, and students, those at other similar institutions, the general public, facility consultants, and any other group that may use your facility. When an institution has determined that more space is needed for current or projected programs, exploratory meetings are essential for determining what to build and how to build it. Remember that the technology is available to build whatever can be envisioned and in the early stages, all ideas are valuable.

It is highly recommended that a professional consultant be hired to advise the planning committee. Experienced consultants can save a project many times the amount paid for their salary. The consultant should be brought in on the project as early as possible. A qualified consultant will bring a professional orientation and practical experience in overcoming the problems often encountered in the planning process. The consultant can help to educate the committee

about current trends and innovations, making efficient use of space, and may show photo or slide examples of good and bad facilities. Other areas of advice may include recommending experienced architects, helping to select the architect, ideas on financing, recommending materials, and acting as a go between with the planning committee and the architect. A professional consultant is paid only for advice and can be a very valuable asset to the overall project.

Site Selection

Intelligent and imaginative facility site selection and development are significant aspects of the overall planning process. The site can affect the desired programs, budget, transportation and parking, landscaping, and numerous other program components. A few of the important factors that the site selection process must take into consideration include accessibility, relationship to existing facilities, drainage, aesthetics, climate, topography, property lines and easements, utilities, parking, and security.

A primary requisite for a satisfactory site is adequacy of size. The size of the facility should be determined by careful study of the present and future needs of all programs, existing facilities, and available funds. The site must be large enough to accommodate the desired activities and all support areas such as parking, storage, and room for future expansion. The site should be readily accessible to the primary users. In the case of a college or university campus recreation center, a location near the dormitories and student housing might be desirable. Large spectator facilities should be situated where the

public will have easy access and parking. It may also be desirable to separate the facility from other buildings.

Facilities must be located to allow for future expansion. It is much easier and cheaper to plan for growth from the beginning than to try and 'shoehorn' an expansion into an unplanned space. If there is a possibility that the size of the facility will need to be increased in the foreseeable future, the method of expansion should be pre-determined and the necessary details incorporated in the original footings and other construction. As far as possible, the requirements for future expansion should be built into the initial structure.

Adequate parking areas adjacent to the facility, with a paved access roadway leading to the building are necessary. When admission is charged for parking, a fence with a minimum height of seven feet surrounding the spectator structure and the enclosed field may be desirable. Gates are necessary for spectator and service entrances and exits. Admission gates should be located near the parking lots and other main approaches to the structure. The number and size of the entrances depends on the projected and potential attendance. Exits should permit the crowd to vacate the enclosure within 10 minutes. At least one gate 14 feet high and 14 feet wide should be provided to accommodate trucks and buses. Surface drainage of the site and adjacent areas as well as the subsurface soils and geological formations must be considered.

Areas with two or more similar organizations or schools may consider the construction of one facility for their combined use. Teams from each school may practice on local fields and play their regular games at the stadium. If possible, the structure should be

located on or adjacent to one of the schools' sites for reasons of greater accessibility, maximum use, and more efficient maintenance, operation, and supervision.

An idea that has recently gained favor on some large university campuses are satellite facilities, located at several different areas on campus usually near dormitories or student housing. This makes recreational areas readily available to the students and eliminates the need for locker room facilities on site. Locating facilities where the students are, helps to promote recreational participation and can reduce parking problems at the central facility.

Single Use vs Multi-Purpose Facilities

Building a facility that is ideally suited for a specific purpose means that it is going to be less than ideal for other activities. In order to make a facility adequate for several different events, a number of compromises must be made.

An example is that of one large arena that was built primarily to house a big-time college basketball program. The arena was designed to seat 16,000 fans and there is not a bad seat in the house. The fixed seating goes right down to courtside so that the usable floor area is limited to the size of a basketball court. It is a great spectator facility for basketball. The problem is that this school has only about 15 home basketball games per year. Other than graduation, a few other varsity contests, and a few concerts a year, the arena sits empty the rest of the time. With only one court it's not even cost efficient to turn on the lights for intramurals or recreation. If the first several rows of seats had been roll-away bleachers, a larger court area would have

made the entire facility more functional. There are always trade-offs to consider. In this case the original designers felt that looks and comfort for basketball were more important than multiple function.

Too often, single purpose facilities are not cost efficient and they become liabilities rather than assets. Many large spaces, constructed primarily to serve an athletic team, become financially self-supporting only by serving a variety of other events. The continual emergence of new synthetic materials, improved building techniques, and changing program needs can complicate the planning of a functional athletic, physical education, recreation facility. Certainly the trend is to construct multi-purpose facilities with the flexibility to adapt to a number of diverse needs.

Modules

A module is a specified area that makes optimal use of a limited amount of space. One of the most common module sizes is a space 100' x 124'. An area this size can accommodate a full size competition basketball or volleyball court, two practice basketball courts, three volleyball courts, or six badminton courts. The two basketball practice courts are each 84' x 50' with eight feet of clear space on each side and between them. The two practice basketball courts will be at right angles to the main court (94' x 50') that will be located in the center of the gym. Decreasing the area of a module would entirely change the number and/or size of the courts that can be accommodated while minor increases in the size of the module will not result in more courts. Gymnasiums are often referred to by how many modules they contain, i.e. a one module or two module gym.

Lighting

The use of natural lighting, or fenestration, should be considered in the planning stage. Natural lighting can reduce electric power consumption and can also improve the aesthetics. Natural light may be introduced through the use of windows, skylights, fabric roofs, and clerestories. Windows should be located to prevent the interference of sunlight with player performance or spectator viewing at any time during the day. In general, windows along a north wall will admit the best light and will be easiest to prevent the admittance of direct sunlight.

Artificial lighting may be provided by incandescent, fluorescent, or high intensity discharge (HID) lights which include mercury, metal-halide, and sodium vapor lighting fixtures. Many users prefer metal-halide lighting because they provide excellent color-correct light at a very low operating cost. In order to enhance the lighting system used, light color surface treatments for walls, ceilings, and flooring should be considered. This helps to reflect available light and makes it easier to track balls moving at high speed.

The amount of lighting within different activity areas is often inadequate. Uniform and adequate illumination is necessary for proper judgment of moving objects. As a rule of thumb, the smaller and faster moving the object that must be watched, the more illumination that is required. More light is necessary to safely play racquetball than for weight training or swimming. It is recommended that a minimum of 100 foot candles be available on all courts and gyms. Swimming pools, weight rooms, dance studios, etc. should have at least 50 foot candles and a minimum of 100 foot candles if spectators

or television cameras will be present. Careful consideration must also be given to the proper placement and aiming of lights.

It is best to overestimate the lighting needs for each area because illumination systems tend to lose brightness over time. It is not unusual to have a new system that produces 100 foot candles of illumination and have it drop to 75 foot candles after five years of operation. Standards for the design and location of lights are published by the Illuminating Engineering Society of North America (Sports Lighting).

Controls for gymnasium lighting should be conveniently located. A central control panel within the administrative area that controls all major lighting in the building should be considered. If the controls are to be located at or near the activity area, they should be recessed, and keyed. When the lighting system is being planned, the initial costs should be compared with replacement costs and operational or electrical expenses since some systems are less expensive to install but are very expensive to operate or maintain. Any lights in an activity area must be enclosed and protected. This is usually accomplished by covering the lamp with a tempered glass lens and then by an acrylic lens and possibly a wire screen. These coverings will not only reduce the chance of breaking the lamp but will also contain all of the glass and pieces if breakage does occur.

Heating, Ventilation and Air Conditioning

Another area that will cause many problems if improperly designed or engineered is the heating, ventilation, and air conditioning (HVAC) system. Different areas of the facility have

differing requirements for the HVAC system. High ceiling areas need good air circulation in order to keep heat stratification to a minimum. Wet areas such as pools, spas, and shower rooms require dehumidification and a fast turnover rate (ten - twelve air changes per hour) of the air handling system. It is important that the fresh air be introduced into the area so as not to create a draft on the occupants. Enclosed areas that are likely to have occupants who sweat a lot, such as weight rooms and racquetball courts also need to be able to turn over the air quickly in order to remove odors and humidity. It is recommended that each different area be individually thermostatically controlled if possible.

Where climatic conditions permit, evaporative cooling systems should be considered. These systems can cost up to 80 percent less than mechanical cooling in initial construction costs and also cost less to operate.

Entrances, Exits and Lobbies

User access should be thoroughly considered during the planning process. Control of all entrance and exit points is important in any kind of sports or recreation facility. For recreational facilities it is best to have one point that all people entering and leaving the building must pass through. This is essential for those that will be charging a fee or checking I.D.'s for admittance to the facility.

Many types of security systems exist to control access through both exterior and interior doors. A central control panel located in the facility management office can be installed to electronically lock or unlock doors throughout the facility. This control panel may also

indicate when a door is opened by an unauthorized person so that a facility attendant can be dispatched to investigate.

Some systems use magnetic cards instead of keys to open doors. Controlled by a central computer, records can be automatically kept that document which door was opened, what time it was opened, and whose card was used to open it. This type of system also has the advantage of not having to change all of the locks if someone loses a key. Instead that numbered card is simply canceled in the computer which makes the card worthless to anyone that finds it.

Controlling access to recreational sport facilities is a major concern of the facility operator. Systems now exist that can connect either a magnetic strip or bar-code card reader to a computer and compare the information on a users I.D. card with current information in the computer data base. The user passes their ID. card through the card reader at the building control point and is either admitted or turned away from entering. A picture ID. is usually used and the picture is compared with the user to confirm that the card has not been borrowed or stolen. This type of system can also be set up to record who, when, and how often an individual is using the facility. This information can then be used to determine both who is using and not using the facility. This type of information can be very valuable for targeting certain individuals or groups in a marketing campaign.

Entrances should be located with reference to parking facilities and traffic approaches. Provisions should be made for a paved access roadway and at least one entrance large enough to accommodate trucks. Floor materials and wall treatments should be selected for

their resistance to punishment and ease of maintenance. Handicap accessibility must also be addressed.

A careful analysis of the anticipated pedestrian traffic flow in the building will pay enormous dividends in terms of efficient supervision and lower maintenance costs. All building, health, and fire codes must be considered as a basic guide during the planning process. The architectural style should be designed to conform with the municipal or campus surroundings.

In spectator facilities the lobby should be designed for ticket selling and collecting so that the traffic will flow in as straight a line as possible from the entrances to the ticket windows to the ticket collectors. To avoid congestion, approximately two-thirds of the lobby should be planned for accommodating box offices and ticket purchasers. The remainder should be reserved for ticket holders, who should have direct access to admission gates. The main lobby should be of sufficient size to accommodate anticipated crowds checking tickets and admission, particularly in colder climates.

The seating capacity and the number of seats in each section will determine the number of entrances and exits required. It is important that spectators be able to leave quickly. It is highly desirable to have exit ramps leading from stepped aisles. Ramps, stairs, and passageways should be as wide as the deck aisles served.

Good traffic control should permit the efficient movement of users to and from the gymnasium, locker rooms, and other related service areas. All traffic arrangements for spectators should provide direct movement to and from seating with a minimum of foot traffic on gymnasium floors. Spectators should have access to drinking

fountains, concession stands, and rest rooms without crossing the gymnasium floor. Steep, high stairways should be avoided.

Facility Management Offices

The facility administrative offices serve as the focal point for most business and management functions within the facility. The most efficient location for these offices is often very near the main entrance. In the case of a facility that allows only limited access, it may be desirable to locate the offices of the facility manager and staff at a point just outside the control point. This allows those with business or other visitors, access to the office without having to provide ID. or pay.

It may be advantageous to locate assorted building controls in the main office. These controls may include master lighting controls for the entire building, the public address system, a centralized security system, and controls for the heating, ventilation, and air-conditioning.

Rest Rooms

All events that attract spectators require public rest room facilities. Rest rooms should be designed for proper light, ventilation, maintenance, sanitation, and for handicapped usage. Separate toilet facilities in sufficient number for men and women spectators should also be provided close to the seating areas and near traffic lanes. Many spectator facilities are now building more women's toilets than men's as a response to complaints. Where large crowds attend games, it is advisable to place supplementary toilet facilities off the main lobby.

The number of authorized building users, the capacity of spectator seating, and the state and local building codes will dictate the number and location of toilet facilities.

For spectator facilities that must accommodate large numbers of people simultaneously, consideration should be given to designing rest rooms with a one way traffic flow. Separate in and out doors at different ends of the room can ease congestion during rush periods. It may also be beneficial to plan for a section of the rest room to be closed off for smaller crowds. This can greatly reduce cleaning, maintenance, and repair costs when large rest rooms are not needed.

Storage

The single most common complaint and the one thing that most sport and recreational facilities have in common is a lack of adequate storage space. These areas are usually the first to be removed from the plans if the budget is tight or are often converted into something else that was neglected during the planning stage. It is essential to have adequate and conveniently placed storage space if the facilities are to be fully usable.

Lockable storage space must be provided for both small and large equipment and supplies. Large equipment such as standards, nets, mats, etc. should never be stored on the floor of an activity area. Equipment that is not properly stored is subject to abuse, theft, and may be a cause of accidental injury. With the prevalence of lawsuits these days, liability is a constant concern.

After a building is completed, it is practically impossible to add storage space unless that space is taken from areas designed for other

uses. Realistic planning of storage space should be done while determining total space requirements. Adequate maintenance and control over supplies and equipment is possible only when proper storage space exists.

A large storage room should be located adjacent to the gymnasium floors. These storage areas should be directly accessible to the gym floor through a double door without a threshold or center post. For safety reasons, the doors should open inward and be easily secured. Locks that always re-lock upon closing may be considered. The storage room may contain lockable storage cabinets and deep shelving for storage of smaller, loose equipment. Much of the shelving should be adjustable to best accommodate changing needs.

Spectator Seating

If possible, the seating capacity of a stadium or arena should be sufficient to meet present needs as well as the needs for the foreseeable future. If building the desired number of seats is not possible, planning for later expansion to satisfy predicted needs for a period of at least 20 years is recommended. The number of seats required will be influenced by the activities offered, enrollment (if planning for a school or college), budget, population and socioeconomic status of the surrounding area, and planned expansion of the program. Providing a greater number of seats than is realistically required can be a financial disaster that can only be avoided by careful planning and research.

Along with the total number of seats, another important question that must be answered is just how to provide those seats. Are all of

the seats going to be permanent or will some or all be supplied by portable bleachers? Portable bleachers are usually not as comfortable as permanent seats but can be moved to allow for an increase in activity space.

When bleachers are extended, the first row should be a minimum of 10 feet away from the court sidelines and end lines (12 feet for volleyball). The amount of storage space required to store bleacher units varies greatly and should be determined during planning.

Portable bleachers may also be used as movable walls or dividers to separate activity areas.

Sight Lines

Seating facilities should be constructed to provide spectators with a good view of the performance. Nearness and an unobstructed view of the desired points affect the quality of the building as a spectator facility. A sight line is a straight line from the eyes of the seated spectator, over the heads of others below, to a point on the field or court that represents the spot nearest the structure that should be in the field of vision.

It is essential to consider sight lines in the planning stages of any spectator facility. One major track and field stadium was built so that over 40 percent of the seats did not have a clear view of the finish line. Many baseball stadiums with high outfield fences limit the sight of the spectators seated beyond the fence. The right field fence at the Metrodome in Minneapolis, MN does not allow many of those in the right field seats to see the outfield areas near the fence.

Recommended focal points for sight lines are as follows: for football, the nearest side boundary lines; for basketball, about knee height of a player along the nearest side or end line; for baseball, several feet behind the catcher; for track, about knee-height of the runner in the nearest lane; for side seating for tennis, four feet in toward the seats from the doubles boundary line; and for end seating for tennis, 10 feet behind the base line.

Other Considerations

The height of the ceiling in the main gym should be at least 30 feet clear to accommodate power volleyball and to provide for proper sight lines for all spectators.

Acoustical treatment of ceilings and walls is important where spectators will be present or if teaching is to take place. There are many types of acoustical treatment available, however those that will chip or break when hit with a ball should be avoided.

A first-aid room should be considered especially if it will be a spectator facility. This room may also serve as a training room if desired but it should be located within easy access of spectator areas.

To determine requirements for ramps, stairs, exits, doors, corridors, and fire-alarm systems, planners should consult local, state, and federal laws and the local building, health, safety, and fire codes.

Common Design Errors

A recent informal survey of athletic and recreational building managers found that the most common design errors include the following:

- Lack of adequate storage space.
- Inadequate lighting.
- Failure to consider operating costs during planning phase.
- Too much wasted space.
- Not planning for maintenance.
- Poor traffic patterns.
- Assuming that all architects know what is best for you. It is not uncommon for the architect selected to design an athletic, physical education, or recreation facility to have never worked on this type of project before. Also, the primary concern of many architects is to design a pretty building, which may be done at the cost of function. The building managers surveyed stressed that the planning committee should research and feel comfortable with the architects recommendations and designs.

INNOVATIONS IN TYPES OF CONSTRUCTION

The ability to enclose vast surface areas to accommodate multipurpose field layouts has created the opportunity to develop a variety of construction techniques. Tension structures, air-supported fabric structures, wooden domes, geodesic domes, and cable domes are examples of building designs that have been successfully used in enclosing large sports facilities.

Geodesic Domes

The geodesic dome offers one of the many options in types of construction. Invented by American architect Buckminster Fuller, a

geodesic dome is a framework to enclose space. In technical language a geodesic dome is the result of a series of physical and complex mathematical properties that create a lightweight, strong, possibly transportable and economical structure that can be used in a multitude of ways. It is made by precisely interlocking triangles that appear as a series of hexagons on a completed building. Enormous spans and heights can be achieved, including a complete sphere, without the need of inside support walls. The familiar half-sphere shape has given way to many complicated shapes as engineering knowledge and confidence has progressed.

Fabric Structures

A fairly recent development in the area of physical education, recreation, and athletic facilities is the concept of fabric structures. The fabric used most commonly is a Teflon coated fiberglass material. The fiberglass yarn used to make the material is pound for pound stronger than steel and is also less expensive. It can be designed to allow either a large amount or very little natural light to penetrate. The fabric can withstand temperatures of 1300 to 1500 degrees Fahrenheit and is not adversely affected by cold or the ultraviolet rays of the sun. Fabric structures offer a number of possible advantages and disadvantages when compared with standard construction.

Advantages

- **Lower Initial Cost** - Initial costs are usually lower than with conventional construction. Several factors contribute to this, the primary one being weight. A fabric roof is 1/30 the weight

of a conventional steel truss roof. This reduced weight means that the walls, footings, and foundations are not required to be nearly as strong as in a conventional building.

- **Less Construction Time** - The amount of construction time is directly related to the initial cost of the structure. The total time necessary to build a fabric structure is usually less than for a conventional roof.
- **Natural Lighting** - Since the fiberglass fabric material that is used is translucent, it results in a higher amount of interior natural lighting. Without using artificial lights during the day, the light intensity inside can vary anywhere from 100 to 1000 foot candles, depending on the weather conditions, the design, and choice of the fabric. The interior light is considered to be of high quality because it is non-glare and shadow-free.
- **Possibly Lower Energy Costs** - In some climates or regions, energy costs may be substantially reduced by the fabric's translucency. The large amount of natural light may reduce or eliminate the need for artificial light during the daytime. This may also reduce the need for air-conditioning required to overcome the heat generated by the artificial lights.
- **Less Maintenance** - The non-stick characteristics of Teflon allows the fabric to be washed clean each time it rains.
- **Full Utilization of Space** - Depending on the fabric structures' configuration and support, the area that can be enclosed is almost limitless.

Disadvantages

- **Life span** - The fabric envelope in use today has a life expectancy of up to 25 years, with longer-life materials being tested. All other items such as the foundation, flooring, and mechanical equipment have the life span of a conventional building.
- **Poor thermal insulation** - In cold climates there may be an increase in energy cost when compared with conventional construction due to lower insulating properties of the fabric roof. The insulating value of a typical fabric roof is about R-2 but can be increased substantially (see Lindsay Park Sports Centre). The cost of heating is a significant factor and should be evaluated against that for a conventional building over time. During winter months when the heat is required to melt the snow or to cause it to slide off, a safe level of temperature will have to be maintained at all times at the expense of heating costs. If the bubble is not to be heated during the inactive hours, it will have to be supervised constantly for the dangers of unexpected snowfall. In the summertime the heat gain of the air-supported structure may pose a cooling problem.
- **Acoustic problem** - The curved shape of the air-supported structure produces a peculiar acoustic environment. This poses limitations on its use for large gatherings and open-plan arrangements for different groups.
- **Restriction due to wind.** - In winds of hurricane velocity, most codes require that the structure be evacuated.

There are three basic types of fabric structures in use today. These three types are tension structures, air-supported structures,

and cable domes. Tension structures are made by stretching fabric between several rigid supports. Air structures are sealed buildings which, through the use of fans, maintain a positive internal air pressure that supports the roof. These structures are actually inflated like a balloon and must maintain the positive air pressure to remain inflated. Cable domes are the newest type of fabric structure. The cable dome is actually a modified tension structure. A complex network of cables and girders are erected to support a fabric roof.

Tension Structures

Some projects lend themselves more naturally to tension structures than to air-supported structures or cable domes. Some of the conditions in which tension structures may be more favorable are as follows:

- Free and open access from the sides is desirable or required.
- A unique design or aesthetics are of importance.
- The facility will be largely unattended or not monitored.
- Possible deflation of an air structure would constitute a severe operational or safety problem.
- A retrofit to an existing building or structure such as a swimming pool or an outdoor stadium is desired.

Examples

- **Knott Athletic Recreation Convocation Center** - Located at Mount Saint Mary's College in Emmitsburg, Maryland, the Knott Center is a unique combination of standard construction and a fabric tension structure. Completed in 1987, most of the facility is built with

standard brick construction with the tension structure field house connected onto one side of the building. The fabric roof covers 30,000 square feet of activity space including a multiple court set-up and a ten lap per mile running track. Rising to a height of 40 feet, the double layered roof provides allows for almost exclusive use of natural light during the day. Also included within the facility are four racquetball courts, locker rooms, and a 25 yard pool.

• **La Verne College** - La Verne College in La Verne California contains the first permanent enclosed fiberglass structure in the United States. The tent-like structure covers 1.4 acres with the fabric roof having been erected in just three days. Called the Campus Center, it contains a gymnasium that seats 900 people, men's and women's locker rooms, offices, the campus bookstore, and lecture areas. A smaller separate tension structure houses the drama department. Completed in 1973.

• **Hanover Park Recreation Center** - This city-owned community recreation center is located in Hanover Park, Illinois. It houses six tennis courts and a gymnasium. Completed in 1976.

• **Lindsay Park** - The Lindsay Park Sports Centre in Calgary, Alberta, Canada, houses a 50-meter pool, a diving pool, a fully equipped 30,000 square foot gymnasium, and a 200 meter running track. The roof is unique in that it was designed with insulation that is rated at R-16. This compares with a typical fabric roof that has about an R-2 rating. Despite the great improvement in insulating qualities, the fabric roof is still translucent enough to allow for an interior illumination of about 200 foot candles. Completed in 1983.

• **McClain Athletic Training Facility** - Completed in 1988, this field house is located at the University of Wisconsin at Madison, WI. Due to site restrictions, this $9.5 million facility contains an 90 yard football field instead of a full size field. Most of the 76,380 square foot field is covered by a 42,000 square foot fabric-tension roof that admits up to 750 foot candles of natural light into the structure. When comparing the fabric roof to standard construction, it is estimated that the increased cost for heating and the reduced cost for artificial lighting, results in an overall saving of about $21,000 per year. Below the synthetic turf field lies a full 64,320 square foot basement that contains locker rooms for football, track, and coaches, weight room, training facilities, and therapy pool. The therapy pool is 15 x 40 feet and goes from four to seven feet in depth. Also included in the facility are an auditorium, six meeting rooms, and a film room.

Air-Supported Structures

There are two basic types of air-supported structures. These include the large permanent structures and smaller, more portable structures.

Air-supported fabric structures are supported by a positive air pressure within a totally enclosed building. This positive air pressure is produced by a group of large fans. In conventional buildings the foundation, walls, and internal columns must support a roof weight of between 10 and 40 pounds per square foot. On the other hand, in air-supported structures, a roof weight of about one pound per square foot is transmitted directly to the ground by the increased pressure. This increases air pressure of about four or five pounds per square foot

greater than ambient pressure and is usually unnoticed by the building's occupants. Some of the instances when an air structure may be preferable to a tension structure or standard construction are:

- When column-free spans of greater than 150 feet are desired.
- When large, column-free spans are desired at a cost that is greatly reduced compared to conventional structures. In fact, cost per unit area usually decreases as the size of the span increases.
- When a low silhouette is desired.

In spite of the many advantages of the large air-supported structures, their days may be numbered. The primary disadvantage of air-supported structures is the need for the constant positive air pressure. Since this positive pressure is what supports the roof, if there is even a temporary loss of pressure, the fabric will hang down on the supporting cables. Although this alone should cause no damage to the facility, this is when the structural system is the most vulnerable. Even light winds, snow, or rain may cause extensive damage to a fabric roof in the deflated position. These facilities must be constantly monitored and all precautions must be taken to ensure that all systems are functioning properly. Cable domes appear to have the same advantages as the large air-pressure structures but with fewer problems. It is entirely possible that we have seen the last large air-supported structure that will ever be built. See Cable Domes.

Examples

• **Dedmon Center** - Located at Radford University in Radford, Virginia, the Dedmon Center was constructed for a cost of $6,750,000 and opened in 1982. Encompassing 110,000 square feet, it has 5,000 temporary seats for basketball. Used for physical education, athletics, and recreation, the center provides five full basketball courts, weight room, pool, locker rooms and offices.

• **Thomas E. Leavey Activities Center** - This physical education and athletic complex is located at the University of Santa Clara in Santa Clara, California. It contains a 5,000 seat arena for basketball and volleyball along with racquetball courts, wrestling, gymnastics, weight training and conditioning areas, conference rooms, staff offices, and a 25-meter swimming pool. The pool is covered by a separate air-supported fabric roof that can be removed in the summertime, converting it into an outdoor pool. Completed in 1978.

• **DakotaDome** - Located at the University of South Dakota in Vermillion, South Dakota, the DakotaDome contains five basketball/volleyball courts, two tennis courts, an eight-lane 200 meter track, four racquetball courts, six lane 25-meter pool, locker rooms, classrooms, and the offices for the athletic department. The main floor is a synthetic surface that is used for most court activities and has an artificial turf football field that can be rolled out for football, soccer, and other field events. When the facility is set up for football there is seating for 12,000 spectators. The entire facility was built for the bargain price of about $51 per square foot Completed in 1978.

• **Carrier Dome** - The Carrier Dome, located in Syracuse, New York, is the home of Syracuse University athletics. The stadium seats 50,000 for football and over 30,000 for basketball. Also a great

bargain, total construction cost was $27,715,000, which figures out to $554 per seat. This is very inexpensive when compared to conventional covered stadiums. Completed in 1980.

• **Silverdome** - The Silverdome, located in Pontiac, Michigan, has the largest capacity of any indoor stadium in the world. Opened in 1975, the Silverdome has permanent seating for over 80,000 spectators for football and has accommodated over 90,000 for special events. The inflated fabric roof covers an area of ten acres and is maintained at a height of 202 feet above the playing surface. The Silverdome is owned by the city of Pontiac and is currently the home of the Detroit Lions.

Other Examples:

- **Steve Lacy Field house** - Milligan College, Milligan, TN - 1974.
- **Uni-Dome** - University of Northern Iowa, Cedar Falls, IA - 1975.
- **Sun Dome** - University of South Florida, Tampa, Florida - 1981.
- **Metrodome** - Minneapolis, Minnesota - 1982.
- **B.C. Place Amphitheater** - Vancouver, B.C., Canada - 1983.
- **Hoosier Dome** - Indianapolis, Indiana - 1984.

Since the concept of fabric structures is still quite new, not all the problems have been resolved. However, each new fabric structure appears to have fewer problems and to be an improvement over those built previously.

Combining Air-Supported and Tension

A recent development in the construction of fabric structures is the idea of combining both an air-supported roof and a tension roof in the same building. An example of this concept is the **Stephen C. O'Connell Center.** This physical education, recreation, and athletic complex is located at the University of Florida at Gainesville. This was the first structure to combine both air-supported and tension roofs in one building. The center or main arena is covered by a large air-inflated roof while the outer areas of the building are the tension covered spaces. The main arena has an indoor track and can seat 10,400 spectators for basketball. Located under the tension supported areas are a gymnastics area, dance studio, weight room, locker rooms, offices, and a 3,000-seat, 50-meter natatorium. Like most fabric structures, this facility was a bargain. The total construction cost was $11,954,418 which comes out to about $49 per square foot. Completed in 1980.

Portable Air-Structures

This section will discuss the merits of the smaller and more portable air structures. Air structures work well as environmental covers placed over existing recreational areas and, for many organizations, the 'Bubble' is the answer to an increasing need for large covered activity areas at a nominal cost. Cost savings are in proportion to the size of the space to be covered. Spaces over 300 square feet usually bring a cost savings when compared to conventional roofing. Because of heat gain, which seems to present a more severe problem than heat loss, the northern areas of the United States seem better suited for environmental covers. There are numerous playing

fields within communities and around schools and colleges that lend themselves easily to enclosure by a fabric air-structure. Some of the additional advantages and disadvantages of using small air-supported structures are as follows:

Advantages

- **Speed of erection** - The actual erection of the structure usually takes only one or two days. However, additional time is required for the ground work, site services, foundation, anchorage, flooring, and installation of mechanical and electrical equipment. Only minimal field labor is needed.
- **Ease of deflation, inflation, and repair** - Deflation and inflation of the fabric envelope usually does not require skilled labor.
- **Portability** - When deflated and packed, the fabric envelope can be stored in a small space or easily transported elsewhere for storage or use. Depending on the size of the dome, deflation and packing usually requires one or two days.
- **Adaptability for temporary functions** - For temporary use, the air-supported structure has definite physical and financial advantages over a conventional building.
- **Long-span and high-ceiling features** - Clear and unobstructed spaces is an inherent feature of the structure. Conventional long-span and high-ceiling structures are much more expensive.

- **Integrated heating, ventilation, and air-pressure system** - The integrated heating, ventilation, and air-pressure system is simple and less expensive than conventional systems. Lengthy duct and pipe works are not required.

Examples

- **Memorial Stadium** - A portable inflatable fabric bubble is used to cover the entire football field at the University of Illinois in the winter. First erected in 1986, it was purchased for $1.5 million. With an average inside winter temperature of 55 degrees, the field is used heavily by several departments across the campus. The concept of a portable dome over the game field adds extra use to a facility that would otherwise sit empty much of the year.

- **University of Santa Clara** - The swimming pool at the Thomas E. Leavey Center is covered by a portable air structure. It is removed for use as an outdoor pool in the summer months and then re-inflated for the winter to transform the pool for indoor use.

- Numerous public and private tennis complexes, pools, and golf driving ranges across the country.

Cable Domes

Cable domes are the most recent innovation in fabric structure technology. Through a complex system of cables and girders, very large spans can be inexpensively covered by a fabric roof without the need for columns or fans to maintain integrity. Engineers predict that the cable dome concept is feasible for spans of at least 1,000 feet. Cable domes incorporate most of the advantages of fabric structures

when compared to standard construction, and fewer of the disadvantages. Many experts in fabric roof technology believe that cable domes will replace the air-supported structure as the design of choice for the future. There will probably not be any more large air structures built because of the inherent advantages of the cable dome. Some of these advantages are as follows:

- Huge column-free spans can covered.
- No need for expensive energy consuming fans.
- Passive system - no need for someone to constantly monitor facility.
- Extremely low silhouette.

Examples

- **Redbird Arena** - Opened in 1991, Redbird Arena is on the campus of Illinois State University in Bloomington-Normal, Illinois. This multi-purpose arena can seat 10,500 spectators for basketball with the ability to add an additional 1,500 seats on the floor for concerts or commencement. The lower sections of seats are portable bleachers that can be removed to provide 36,000 square feet of space on the main floor. Built for a cost of $20,000,000, Redbird is the first cable dome to be constructed on a college campus, but probably won't be the last.

- **Suncoast Dome** - The Florida Suncoast Dome is located in St. Petersburg, Florida and was opened in 1990. This multi-purpose stadium was designed primarily for baseball, yet with the flexibility to accommodate football, basketball, soccer, tennis as well as concerts and trade shows. In addition to 50 private suites, a variety of seating

arrangements allow the facility to function as an 18,000 seat arena or a 43,000 seat stadium for baseball. The unique movable grandstands contain built-in concession stands and public toilets. The fabric roof is 688 feet in diameter and was constructed on a tilt of 6°. This tilt is designed to allow more clearance for the trajectory of fly balls and allows the roof to reach a height of 225 feet in front of home plate. The cable truss roof system is capable of supporting 60 tons of lighting and sound equipment for concerts yet weighs a mere six pounds per square foot. The Suncoast Dome was built for a cost of $132 million.

• **Georgia Dome** - Located in downtown Atlanta, GA, the Georgia Dome was completed in August, 1992. This $210 million structure is scheduled to be the site of the Super Bowl and the Olympics in 1996. The Teflon-coated fabric roof covers 8.6 acres, weighs 68 tons, and incorporates 11.1 miles of steel support cables. This multi-purpose facility seats 70,500 for football and is the new home of the Atlanta Falcons. A total of 202 Executive Suites are located on different levels around the stadium that range in price from $20,000 to $120,000 per year for a ten year lease. During the planning process it was estimated that changing the design from an open air stadium to a fabric covered dome would only increase the cost of the project by 20% or less.

Wooden Domes

Another recent development in the area of encapsulated spaces are wooden domes. These spherical wooden structures have several advantages over conventional structures. Column-free spans of up to 800 feet are possible, and they are generally easier to build. There are

several wooden dome structures around the country ranging from high school gymnasiums to very large arenas. Some of the advantages of wooden domes when compared with standard construction may include:

- Huge column-free spans can be constructed efficiently
- Lower initial cost when compared with conventional construction
- Less construction time
- Full utilization of space
- Good acoustical properties

Examples

- **Round Valley Ensphere** - Located in Eager, Arizona, this wooden dome is the only high school domed football stadium in the world. Opened in 1991, it was built for a total project cost of only $11.5 million and is unique in many respects. The 113,000 square feet of unobstructed floor space provides a full size synthetic turf football field with seating for 5,000, a six lane 200 meter synthetic surface running track with 100 meter straight-away, seven combination basketball, volleyball, or tennis courts, softball field, as well as offices, training room and four full locker rooms. The wooden roof is insulated to a value of R- 28 and is very energy and acoustically efficient.

One of the most interesting features of the dome is that it contains a large skylight in the center of the roof. This skylight is made of clear Lexan and provides good illumination of the activity areas even on overcast days. At an elevation of over 7,000 feet, the

Round Valley area experiences extremes in weather including snow packed winters. During these colder months, the skylight also acts as a solar collector helping to make the Ensphere very energy efficient.

• **Walkup Skydome** - This laminated wood dome is located in Northern Arizona University in Flagstaff, Arizona. Opened in 1977, the Skydome is 502 feet across and covers 6.2 acres. It contains a full size, roll-up, synthetic football/soccer field, a professional sized ice hockey rink, a 1/5 mile running track, a portable wood basketball court, and has seating for more than 15,000 people. The total construction cost was $8.3 million, or about $620 per seat.

• **Tacoma Dome** - The Tacoma Dome in Tacoma, Washington, was opened in 1983. This $44 million multi-purpose complex is 530 feet across and for eight years was the largest wooden dome in the world. It can seat 20,722 for football, 25,138 for basketball, and contains a permanent ice hockey rink.

• **Superior Dome** - Constructed on the campus of Northern Michigan University in Marquette, MI, this state owned, wooden dome was opened in the fall of 1991. With a diameter of 533 feet, this is now the largest wooden dome in the world and is the fourth largest rigid domed stadium in the United States. The 14 story, $21.8 million structure was envisioned in 1985 as an Olympic training center. It has a 200 meter track, a full size football field and is home to the NMU football team with seating for 8,000 spectators. Designed to be constructed in phases as funding becomes available, plans for the future include an additional 5,000 seats, an ice rink for hockey, speed skating, and figure skating, locker rooms, sports medicine facilities and public use areas.

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